CLAIMS

What is claimed is:

1 A computer-implemented method for automatically calibrating a masking process simulator, comprising the steps of:

(a) performing a masking process using a calibration mask and process parameters to produce a calibration pattern on a wafer;

(b) creating a digital image of the calibration pattern;

(c) detecting edges of the pattern from the digital image using pattern recognition;

(d) inputting data defining the calibration mask and the process parameters into a process simulator to produce an alim image estimating the calibration pattern that would be produced by the masking process;

(e) overlaying the alim image and the detected edges of the digital image;

(f) measuring a distance between contours of the pattern in the alim image and the detected edges; and

(g) using one or more mathematical algorithms to iteratively change the values of the processing parameters input to the simulator until a set of processing parameter values are found that produces a minimum distance between the contours of the pattern in the alim

image and the detected edges, thereby effectively calibrating the process simulator to compensate for process variations of the masking process.

2 The method of claim 1 wherein step (b) further includes the step of: using a scanning electron microscope (SEM) to create an SEM image of the calibration pattern.

3 The method of claim 3 wherein step (g) further includes the step of: changing the values of a subset of the processing parameters.

4 The method of claim 3 wherein the subset of processing parameters includes focus, diffusion, sigma in, sigma out, angle of the pole location, numerical aperture, sigma of the pole, spherical, coma_x, coma_y, and intenstity contour.

5 The method of claim 3 wherein step (g) further includes the step of: receiving from an operator a minimum distance threshold that will be used to terminate the search, and the minimum and maximum possible values for the processing parameters.

6 The method of claim 5 wherein step (g) further includes the steps of:

(i) using a first algorithm to iteratively change the parameter values until a global minimum for a function of the

processing parameters is found;

(ii) inputting a first set of calculated parameter values that produced the global minimum to a second algorithm, wherein the second algorithm begins with the function defined by the first set of parameter values and iteratively changes the values of the parameters until local minimums within the function are found, producing a second set of parameter values.

7 The method of claim 6 wherein the first algorithm is a stochastic algorithm.

8 The method of claim 6 wherein step (g) further includes the step of: iteratively inputting the second set of calculated parameter values into the process simulator to generate new alim images for the distance measurement.

9 The method of claim 3 wherein step (c) further includes the step of: correlating the SEM image to the mask design data in order to determine how many pixels in the SEM image are equal to one unit of measure of the mask design.

10 The method of claim 3 wherein step (f) further includes the step of: determining the distance using a distance metric, including root mean square (RMS) algorithm.

11 The method of claim 10 wherein the distance metric measures a distance between at least a subset of each pair of corresponding edges in the alim image and the SEM image and applies a weighted average to the measured distances to produce a single distance value.

12 The method of claim 11 wherein the weighted average is equal to an Nth root of an average Nth power of distance between the SEM edges and the alim image.

13 The method of claim 3 wherein the alim image comprises an aerial image or a latent image.

14 The method of claim 1 further including the step of: displaying a user interface screen that displays individual graphs for each processing parameter that plot parameter values for each iteration along with resulting distance values, and displays a global graph plotting a global distance result of each iteration.

15 The method of claim 1 wherein step (a) further includes the step of: inputting global processing parameters, which include both resist parameters for simulating photoresist and optical parameters for simulating optics and characteristics of a stepper machine.

16 A process simulator system, comprising:

a server coupled to a network;

a calibration program executing on the server;

a process simulator executing on the server; and

at least one client computer coupled to the server over the network, such that an operator may access the calibration program, wherein once invoked, the calibration program:

(a) receives a digital image of a calibration pattern on a wafer, the calibration pattern produced during a masking process using a calibration mask and process parameters

(b) detects edges of the pattern from the digital image using pattern recognition;

(c) inputs data defining the calibration mask and the process parameters into the process simulator, which then produces an alim image estimating the calibration pattern that would be produced by the masking process;

(d) overlays the alim image and the detected edges of the digital image;

(e) measures a distance between contours of the pattern in the alim image and the detected edges; and

(f) uses one or more mathematical algorithms to iteratively change the values of the processing parameters input to the simulator until a set of processing parameter values are found that produces a minimum distance between the contours of the pattern in the alim

image and the detected edges, thereby effectively calibrating the process simulator to compensate for process variations of the masking process.

17 The system of claim 16 wherein a scanning electron microscope (SEM) is used to create an SEM image of the calibration pattern.

18 The system of claim 17 wherein the mathematical algorithms iteratively change the values of a subset of the processing parameters.

19 The system of claim 18 wherein the subset of processing parameters includes focus, diffusion, sigma in, sigma out, angle of the pole location, numerical aperture, sigma of the pole, spherical, coma_x, coma_y, and intenstity contour.

20 The system of claim 18 wherein the calibration program receives from the operator a minimum distance threshold that will be used to terminate the search by the mathematical algorithms, and the minimum and maximum possible values for the processing parameters.

21 The system of claim 20 wherein the mathematical algorithms include

(i) a first algorithm for iteratively changing the parameter values until a global minimum for a function of the processing parameters is found; and

(ii) a second algorithm that receives a first set of calculated parameter values that produced the global minimum and begins with a function defined by the first set of parameter values, and iteratively changes the values of the parameters until local minimums within the function are found, producing a second set of parameter values.

22 The system of claim 21 wherein the first algorithm is a stochastic algorithm.

23 The system of claim 21 wherein the calibration program iteratively inputs the second set of calculated parameter values into the process simulator to generate new alim images for the distance measurement.

24 The system of claim 17 wherein the SEM image is correlated to the mask design data in order to determine how many pixels in the SEM image are equal to one unit of measure of the mask design.

25 The system of claim 17 wherein the distance is determined using a distance metric, including a root mean square (RMS) algorithm.

26 The system of claim 25 wherein the distance metric measures a distance between at least a subset of each pair of corresponding edges in the alim image and the SEM image, and applies a weighted average to the measured distances

measured distances to produce a single distance value.

27 The system of claim 26 wherein the weighted average is equal to an Nth root of an average Nth power of distance between the SEM edges and the alim image.

28 The system of claim 17 wherein the alim image comprises an aerial image or a latent image.

29 The system of claim 16 wherein the calibration program displays a user interface screen that displays individual graphs for each processing parameter that plot parameter values for each iteration along with resulting distance values, and displays a global graph plotting a global distance result of each iteration.

30 The system of claim 16 wherein processing parameters input to the process simulator comprise global processing parameters, which include both resist parameters for simulating photoresist and optical parameters for simulating optics and characteristics of a stepper machine.